

PATENT

Atty. Dkt. No. APPM008539.Y1/FEP/EPVAG

REMARKS

This is intended as a full and complete response to the Office Action dated March 28, 2006, having a shortened statutory period for response set to expire on June 28, 2006. Please reconsider the claims pending in the application for reasons discussed below.

Claims 1-10, 12-27, 42, and 56-73 remain pending in the application upon entry of this response. Claim 11 has been cancelled and claims 68-73 have been added by the Applicant. Claims 1-10, 12-27, 42, and 56-67 stand rejected by the Examiner. Reconsideration of the rejected claims is requested for reasons presented below.

Claims 1-10, 12-27, 42, and 56-67 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Oda et al., U.S. Pub. No. 2001-0045604, herein *Oda*, taken with Steele et al., U.S. Pat. No. 5,273,930, herein *Steele*, Murthy et al., U.S. Pat. No. 6,235,568, herein *Murthy*, and Hashimoto, U.S. Pub. No. 2002-0142557, herein *Hashimoto*. The Examiner asserts that it would have been obvious for one skilled in the art to combine the four aforementioned references and derive the claimed invention. The Applicant respectfully traverses the rejection.

Murthy, as stated by the Examiner, discloses the deposition of a silicon germanium material having a dopant concentration of ***greater than 5×10^{20} atoms/cm³***, and in one example indicated by the Examiner, a dopant concentration of about 5×10^{21} atoms/cm³. (Office Action, page 4). Contrary to *Murthy*, *Oda* describes forming a silicon germanium material having "the concentration of dopant ... may be 1×10^{19} cm⁻³ or more, with ***the upper limit being 1×10^{20} cm⁻³***, at which diffusion of the dopant is remarkable" (paragraph 136, lines 3-5). *Oda* further states that "the concentration of the dopant may be ***1×10^{20} cm⁻³ or less in order to suppress the diffusion*** to the channel layer." (paragraph 103, lines 26-28).

Therefore, *Murthy* teaches away from "the upper limit being 1×10^{20} cm⁻³," as taught by *Oda*. The Examiner has not provided the required motivation for one skilled in the art to utilize a dopant concentration greater than the upper limit expressly required by *Oda*. *Murthy* does not provide any motivation to use a higher dopant concentration than the upper limit expressly required by *Oda*. There is no motivation to combine a

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dopant concentration of ***greater than 5×10^{20} atoms/cm³***, in one example, a dopant concentration of about 5×10^{21} atoms/cm³, as described by *Murthy* with the method, as taught by *Oda*, for selectively depositing the silicon germanium material having the dopant concentration of ***1×10^{20} cm⁻³ or less in order to suppress the diffusion*** to the channel layer.

Oda discloses a process to selectively deposit a doped silicon-germanium material by a CVD process. *Oda* states "for conducting ***selective growth***, it is ***necessary*** to add a halogenous gas, such as chlorine gas (Cl₂) or hydrogen chloride gas (HCl)." (paragraph 100, lines 19-21). *Oda* describes the importance of the etchant flow rate in order to have selective growth of the silicon-germanium material on the substrate. *Oda* further states "the amount of HCl flow rate ***required for not depositing*** polycrystalline silicon-germanium on the silicon oxide film and the silicon nitride film is from 20 to 80 ml/min. If the HCl flow rate is less, the ***selectivity is lost***, and polycrystalline silicon-germanium starts to deposit on the mask material. On the other hand, if the HCl flow rate is excessive, the [epitaxial] ***single-crystal silicon-germanium layer is not grown***." (paragraph 100, lines 28-34).

Steele discloses "a method of non-selectively depositing a semiconductor seed layer on both a semiconductor material and a dielectric material" (column 7, lines 5-7, also see column 5, lines 24-37). Even the title of *Steele* (Method of Forming a ***Non-Selective*** Silicon-Germanium Epitaxial Film), as well as the claims of *Steele* (e.g., See Claim 1 – A method of forming a ***non-selective*** silicon germanium epitaxial film) are drawn to non-selective silicon-germanium deposition. *Steele* states that "the deposition of a semiconductor material from a ***source gas containing chlorine is selective***, thus epitaxial ***deposition occurs on a semiconductor material and not on a dielectric material***," while "[t]he ***present invention*** teaches a method of forming a ***semiconductor seed layer*** or a nucleation layer ***on both a semiconductor material and a dielectric material***." (column 2, lines 37-46).

Therefore, *Steele* teaches away from the selective growth of the silicon-germanium material taught by *Oda*. The Examiner has not provided the required motivation for one skilled in the art to utilize a non-selective deposition to selectively deposit the silicon-germanium epitaxial layer as required by *Oda*. *Steele* does not

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provide any motivation to selectively deposit the silicon-germanium epitaxial layer as required by *Oda*. There is no motivation to non-selectively grow a semiconductor seed layer on both a semiconductor material and a dielectric material and subsequently deposit a second material thereon as described by *Steele* with the method, as taught by *Oda*, for selectively depositing the silicon germanium material on a semiconductor material and not on a dielectric material.

Hashimoto discloses a low pressure chemical vapor deposition (LP-CVD) process for forming silicon germanium layers. The Examiner asserts that *Hashimoto* discloses depositing "a silicon germanium carbon having **a carbon source** (paragraph 0083)." (Office Action, page 4). The Applicant respectfully traverses this statement.

Hashimoto discloses that "in the case of SiGeC, i (intrinsic) -SiGeC, a p-type SiGeC, and an i (intrinsic)-Si are grown in the order from the bottom layer to form the epitaxial layer 19." *Hashimoto* does not disclose **a carbon source** for depositing a silicon-germanium-carbon layer. *Hashimoto* simply discloses that a layer may contain silicon-germanium-carbon and does not provide a process to form the silicon-germanium-carbon. Also, *Hashimoto* does not disclose the selective deposition of the silicon-germanium-carbon. Although the Examiner did not assert, the Applicant declares that the claimed carbon source is not even inherent in *Hashimoto* since silicon-germanium-carbon may be formed by a deposition processes not described by *Hashimoto*, such as carbon implanting silicon germanium.

Therefore, *Oda*, *Steele*, *Murthy*, or *Hashimoto* do not teach, show, or suggest a method for depositing a silicon germanium film on a substrate comprising providing a substrate within a process chamber, heating the substrate to a temperature within a range from about 500°C to about 900°C, exposing the substrate to a first deposition gas comprising silane, germanium, a carbon source, hydrogen chloride, a carrier gas, and at least one dopant gas to epitaxially and selectively deposit a first silicon germanium material on the substrate, wherein the first silicon germanium material contains a dopant concentration of about 2.5×10^{21} atoms/cm³ and exposing the substrate to a second deposition gas comprising dichlorosilane and a germanium source to epitaxially and selectively deposit a second silicon germanium material on the substrate, as recited in claim 1, and claims dependent thereon.

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Also, *Oda, Steele, Murthy, and Hashimoto* do not teach, show, or suggest a selective epitaxial method for depositing a silicon germanium film on a substrate comprising placing a substrate within a process chamber, heating the substrate to a temperature within a range from about 500°C to about 900°C, and exposing the substrate to a deposition gas comprising silane, a germanium source, a carbon source, an etchant source, a carrier gas, and at least one dopant gas to epitaxially and selectively form a silicon germanium material containing a dopant concentration of about 2.5×10^{21} atoms/cm³, as recited in claim 14, and claims dependent thereon.

Also, *Oda, Steele, Murthy, and Hashimoto* do not teach, show, or suggest a method for depositing a silicon germanium film on a substrate comprising placing a substrate within a process chamber, heating the substrate to a temperature within a range from about 500°C to about 900°C, and exposing the substrate to a deposition gas comprising a silicon-containing gas, a germanium source, a carbon source, hydrogen chloride, and a boron-containing dopant gas to epitaxially and selectively deposit a silicon germanium material epitaxially on the substrate, wherein the silicon germanium material contains a boron concentration of about 2.5×10^{21} atoms/cm³, as recited in claim 42.

Also, *Oda, Steele, Murthy, and Hashimoto* do not teach, show, or suggest a method for depositing a silicon germanium film on a substrate comprising placing a substrate within a process chamber, exposing the substrate to a first deposition gas comprising silane, a first germanium source, a carbon source, hydrogen chloride, and a carrier gas to epitaxially deposit a first silicon germanium containing material having a first thickness on the substrate and containing a dopant concentration of about 2.5×10^{21} atoms/cm³, and exposing the substrate to a second deposition gas comprising dichlorosilane and a second germanium source to epitaxially deposit a second silicon germanium containing material having a second thickness on the first silicon germanium containing material, as recited in claim 56, and claims dependent thereon.

Withdrawal of the rejection is respectfully requested.


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In conclusion, the references cited by the Examiner, alone or in combination, do not teach, show, or suggest the claimed invention.

Having addressed all issues set out in the Office Action, the Applicant respectfully submits that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,



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